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sufficiently correct according
to our present state of information
on these singular processes—

An Inaugural Essay

On

Saccharine Matter

By

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of

Virginia.

1828.

An essay on Saccharine Matter.

The sensation of sweetness imparted to the organs of taste by every variety of saccharine matter is due to a certain substance called the saccharine or sweet principle. It is abundantly distributed throughout the vegetable kingdom and is a product in some animal secretions. It is almost exclusively obtained from the Arundo Saccharifera for domestic purposes; the juice of this plant furnishes two kinds, one of which is crystallizable and the other incapable of assuming the crystalline form; sugar constitutes the former species and melasses or treacle the latter. Sugar also exists in considerable quantities in the beet, sugar maple, grapes &c. and the uncrystallizable saccharine matter is found nearly pure in honey and as lately ascertained by professor Hare in the sweet potatoe.

White or candied sugar is the saccharine principle nearly pure,

and very probably uncrystallizable saccharine matter consists of this principle united with some proximate principle of organic chemistry; which merely has the effect of retaining it in the liquid state. not yet proven

Professor Hare has very appropriately proposed the term Saccharin to designate the pure crystallizable saccharine principle as a proximate element of organic chemistry: the same term will be adopted in this essay. supposing that it is the only saccharine principle and that all other sweet tasted substances consist of it in combination with other matter.

Saccharin is inodourous, colourless and perfectly sweet to the taste: its specific gravity is 1.6: it undergoes no change upon exposure to the atmosphere except when very humid, it then deliquesces slightly. By exposure to the action of caloric, it first dissolves in its water of crystallization, then becomes discoloured, evolves the peculiar odour called caromel and is resolved into a new arrangement of its component elements: if the temperature be elevated to 500° it bursts into flame, burning white in the centre and blue around its surface: carbonic acid and water are the only products of its combustion, where there is a plentiful supply of oxygen, but when distilled in close vessels it yields carbonic and acetic acids,

carburetted hydrogen gas, charcoal, water and a little oil.

Water at the temperature of 55° is capable of retaining one half its weight of saccharin in solution and its solvent power increases very much with its temperature, so that at its boiling point it will dissolve almost any proportion. Alcohol at the ordinary temperature of the atmosphere scarcely acts on it, but at a boiling heat it is capable of holding about one fourth of its weight in solution, which it precipitates by refrigeration: it is soluble in many of the oils, but insoluble in ether.

It crystallizes from its solutions in four or six sided prisms, having various terminations: its crystals contain 5.6 parts of water according to the experiments of Berzelius.

It has the singular property of emitting a flash of light upon severe friction or concussion of two pieces together; by this operation it looses its sweet taste and is converted into an insipid white powder: the experiment succeeds best when very hard white sugar is used.

The analysis of saccharin has been attempted by many eminent chemists; by Lavoisier it was supposed to be a true vegetable oxide, composed of 28 parts of carbon, 64 of oxygen and 8 of hydrogen; but it is only from

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the improved mode of analysis pursued in modern times, that we are to expect any degree of accuracy. It has been analysed by Berzelius, Prout, Gay Lussac and Thenard by combustion with chlorate of potash and peroxide of copper and as the results of their experiments are nearly coincident, they are entitled to belief. The proportions deduced from them are, in atoms, 6 of carbon, 5 of oxygen and 5 of hydrogen, making its equivalent 81. [hydrogen being assumed as unity.] The analysis of the compound of saccharin and protoxide of lead by Berzelius, supposing it to consist of an atom of each ingredient, corresponds precisely with this deduction.

As a test for saccharin it has been proposed to boil a portion of the substance suspected to contain it in alcohol and set it aside to crystallize, but it is evident that by this means only the crystallizable portion can be detected. A much better method is to add a few grains of yeast to a solution of the substance confined over mercury and note the quantity of carbonic acid evolved upon exposure to a due temperature. By this means the presence of either kind of saccharine matter is detected and their quantity ascertained. When it enters more largely into the composition of a substance, its sweet taste is a sufficient indication

of its presence.

As a medicine, saccharin is almost inert, except when mixed with other substances, as it exists in melasses; it is then slightly purgative but this effect may fairly be attributed to the impurities of the melasses. Upon the healthy system saccharin seems only to act as a nutricious article, and upon some constitutions it exhibits this property in an eminent degree. The property which it possesses of disguising the disagreable taste of many substances, as well as its antiseptic virtues, renders it of great utility in Pharmacy.

Saccharin does not appear to possess any very striking affinity for any class of bodies, though it does unite chemically with several substances: all its compounds except that of uncrystallizable saccharum are distinguished by their facility of decomposition.

Saccharin dissolved in water at the temperature of 55° has the property of retaining one half its weight of lime in solution with it; these two substances appear to increase the solubility of each other reciprocally in this menstruum. This compound is of a white wine colour and has somewhat the smell of fresh slaked lime. The lime is precipitated from this solution by the sulphuric, oxalic, tartaric citric or carbonic

acid. it is also decomposed by the caustic and carbonated potash and soda; the alkaline base uniting to the saccharin by its superior affinity over that of lime. After long repose the solution of this compound in water deposits crystals of carbonate of lime and the saccharin appears to become converted into gum; this fact was discovered by Dr Ure; it took place in a bottle which had been preserved from the contact of the atmosphere for the space of four years; of course nothing but the water and saccharin could furnish the carbonic acid and perhaps only the latter substance is concerned in its production.

Equal weights of saccharin and strontia are held in solution at the temperature of 55°: this compound resembles very much that of lime and saccharin in colour, taste and smell, but it does not appear susceptible of the same change by long repose when excluded from the atmosphere.

Baryta acts more energetically and resembles very much lime, in its habitudes with saccharin. Magnesia and alumina also combine with saccharin, but their compounds are so analogous to the preceding, that they do not require a separate enumeration; they all with the exception of magnesia destroy its sweet taste, but this earth renders it somewhat atable: it is also a mild and agreable purgative.

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The affinity of potash and soda for saccharin is superior to that of the earths and hence their compounds in solution with water are decomposed by these alkalies, either caustic or carbonated. Saccharin may be obtained pure from its combination with potash, by adding dilute sulphuric acid and then precipitating the sulphate by means of alcohol. This compound undergoes a change similar to that of lime and saccharin by long standing, being converted into carbonate of potash and a gum-like substance. The habitudes of soda with saccharin are similar to those of potash.

When protoxide of lead and saccharin are digested together in boiling water, an insipid white powder precipitates, called saccharate of lead by Berzelius— the same nomenclature might with equal propriety be applied to the compounds of saccharin with the alkalies and earths.

Gum appears to be the only vegetable substance with which saccharin is known to unite chemically the substance which these two bodies form resembles the uncrystallizable saccharum, very much when the latter is entirely freed from the colouring and other extraneous matter; alcohol removes a portion of saccharin from both, and the remaining substance when gently evaporated very much resembles that of which the nests of wasps are constructed.

Saccharin is soluble, without decomposition, in diluted sulphuric or

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muriatic acid, but when concentrated they resolve it into water acetic acid and charcoal generally; but under particular circumstances water and charcoal are the only products.

The reaction between nitric acid and saccharin is very energetic; it produces two acids, either the malic or oxalic according to the circumstances under which the experiment is conducted. The nitric acid is decomposed, its nitrogen in combination with two atoms of oxygen is evolved, and the remaining oxygen combines with the hydrogen of the saccharin and leaves the carbon and oxygen in the proportion necessary to form oxalic acid; or if all the hydrogen is not oxygenated, then a corresponding portion of malic acid is formed.

When saccharin is exposed to the action of chlorine, it is converted into malic acid, probably by yielding an atom of its hydrogen to form muriatic acid with the chlorine; but as the hydrogen may also be derived from the water it is impossible to say with certainty from which source it originates, until the composition of malic acid is correctly ascertained.

Phosphuret of lime effects a change on saccharin similar to that effected by the alkalies and alkaline earths but the process cannot be the same, as in the former instances carbonic acid is formed from the saccharin

and in this instance it looses no carbon. The hydrosulphurets, sulphurets and phosphurets of the alkalies and other alkaline earths produce the same change, but it is almost idle to attempt to account satisfactorily for it.

The salts of those metals incapable of ~~decom~~ decomposing water are either partially or entirely decomposed by boiling their solutions with saccharin. In some instances it abstracts the whole of their oxygen and acid and [illegible] the [illegible] as is the case with sulphate of copper and nitrate of mercury; other salts [illegible] their oxygen as corrosive sublimate [illegible]. On account of this [illegible] it has been proposed to administer it in certain cases of poisoning [illegible] but it is more than probable that the same result would not take place in the stomach.

Saccharin is said to render nitrous acid a [illegible] of [illegible] manganese [illegible].

When a solution of saccharin [illegible] is suffered to remain in contact with yeast or certain vegetable substances, it is decomposed; presenting the phenomina of vinous fermentation. These phenomena have been investigated by Lavoisier and Thenard with much precision and their researches fully confirm the theoretical deduction concerning the results of the vinous fermentation. Water is essential to the process and is

decomposed as well as the saccharin: we may therefore view the solution as composed of 6 atoms of carbon 6 of oxygen and 6 of hydrogen [disregarding the yeast, which does not undergo decomposition]. The only results of this fermentation are carbonic acid and alcohol, 2 atoms of each, or 48.89 parts by weight of the former and 51.11 of the latter from 100 parts of pure saccharin. The rationale of this experiment is evident. The solution of saccharin and yeast being exposed to a favourable temperature a reaction ensues and as a part of the yeast is decomposed. The water and saccharine alone furnish the products: the equivalent of water is 9 [hydrogen being unity] and saccharin 81 making together 90; two atoms of carbonic acid equalent 44 being taken from 90 leave 46, two atoms of alcohol or 46. It is doubtful what part the yeast acts in this process, most probably it merely tends to change the order of existing affinities; oxygen gas has lately been affirmed to hasten the fermentation.

These are the most prominent habitudes of saccharin, and they are of such an anomalous character as not to indicate any place in the general classification of chemical bodies for its location. In combining with protoxide of lead alkalies and earths it displays an essential

characteristic of an acid, but perhaps it would be generalizing too far to rank it as such. In the general division of organic principles by Gay Lussac and Thenard it is placed in that class of bodies possessing neither acid nor alkaline properties, but being of an intermediate nature as gum, starch &c. and having no excess of either the oxygen or hydrogen entering into its composition, being precisely in the proportions necessary to form water.

The saccharin of which the properties have just been enumerated, is of vegetable origin but when obtained from the animal kindom in a state of purity, its properties are precisely the same. It may be obtained from the whey of milk and from the urine of persons affected with diabetes mellitus: it always exists in milk, but when obtained from urine it is in consequence of the conversion of urea into saccharin.

The saccharin hitherto spoken of is obtained both that of vegetable and animal creation by means of simple processes for separating the different substances with which it may exist in a state of admixture: but it may be made by chemical means from many of the proximate elements of organic chemistry.

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M. Kirchoff of St. Petersburg accidentally discovered the conversion of starch into sugar by means of dilute sulphuric acid while engaged in some experiments on starch. The experiment has been repeated and confirmed by many chemists since, and it is found that the saccharin obtained exceeds the weight of the starch submitted to experiment, and that no gas is evolved or absorbed consequently the water and starch alone produce the saccharin, for all the sulphuric acid may be detected after the conclusion of the experiment, by adding lime to the solution. The explanation of this experiment is found in the union of water or its elements with starch, at least this is the general opinion of chemists. The process of malting is essentially the same with the preceding experiment. Starch is also converted into saccharin during germination and perhaps the converse happens in the ripening of many vegetables. Perhaps the insipid powder formed by the concussion or friction of two pieces of saccharin, is starch, formed in consequence of the union of an atom of hydrogen and oxygen, at least this is the most plausible way of accounting for the light emitted.

To M. Braconnot we are indebted for some interesting views concerning the artificial production of saccharin and several other [illegible]

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imate principles. He discovered that saccharin may be obtained from the sawings of wood, old linen, paper &c by means of sulphuric acid. These substances are first converted into a gummy substance by concentrated sulphuric acid; lime is added to neutralize the acid, and the gum-like matter boiled with a very small proportion of sulphuric or nitric acid; the solution when evaporated affords saccharin in an impure state. Lignin is the principle which undergoes the conversion, and it suffers two, first into gum and then into saccharin.

Gelatin appears to be the only animal principle which has as yet been converted into saccharin; this change was effected by M. Braconnot by means of sulphuric acid in a manner similar to the preceding processes.

The saccharin thus artificially made is never obtained in an entire state of purity and hence it differs from pure saccharin in some of its habitudes: but there is reason to believe that when perfectly pure their properties are precisely the same.

Many of the preceding experiments scarcely admit of an explan

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ation, and such of them as are explained admit of others equally plausible; it would therefore perhaps be better to wait for more accurate information respecting the proximate principles concerned: for it is by no means certain that the kind and number of each atom entering into the composition of organic elements, alone, gives to each principle its characteristic properties; but on the contrary it is very probable that the same number and kind of atoms may by different modes of arrangement form many different compounds. How else can we account for the extensive catalogue of substances arising from the combination of four elements.

" With four elements then has the bountiful Omnipotence composed the ~~beautiful~~ volume of the living world."